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ABSTRACT

Programed instruction is of interest to the Bell Telephone System which conducts massive employee training programs. Characteristics of the programed method include (1) small steps, (2) continual responding, (3) immediate feedback, and (4) self-pacing. The self-pacing characteristic allows accommodation of individual needs and provides flexibility to course administrators and learners. Students perfer the method to traditional group-paced instruction. Studies report a higher homogeneity of student achievement than is the case with conventional methods. There are limitations to the use of programed instruction. Industrially appropriate programs are difficult to find. Testing the quality of the programs is expensive. Program development is time-consuming and costly. When the subject matter is unstable, when there are few students or when the self-pacing feature cannot be exploited, the method is probably inappropriate. Four programed instruction projects have been introduced in the Bell System. The method will continue to be studied. (KB)

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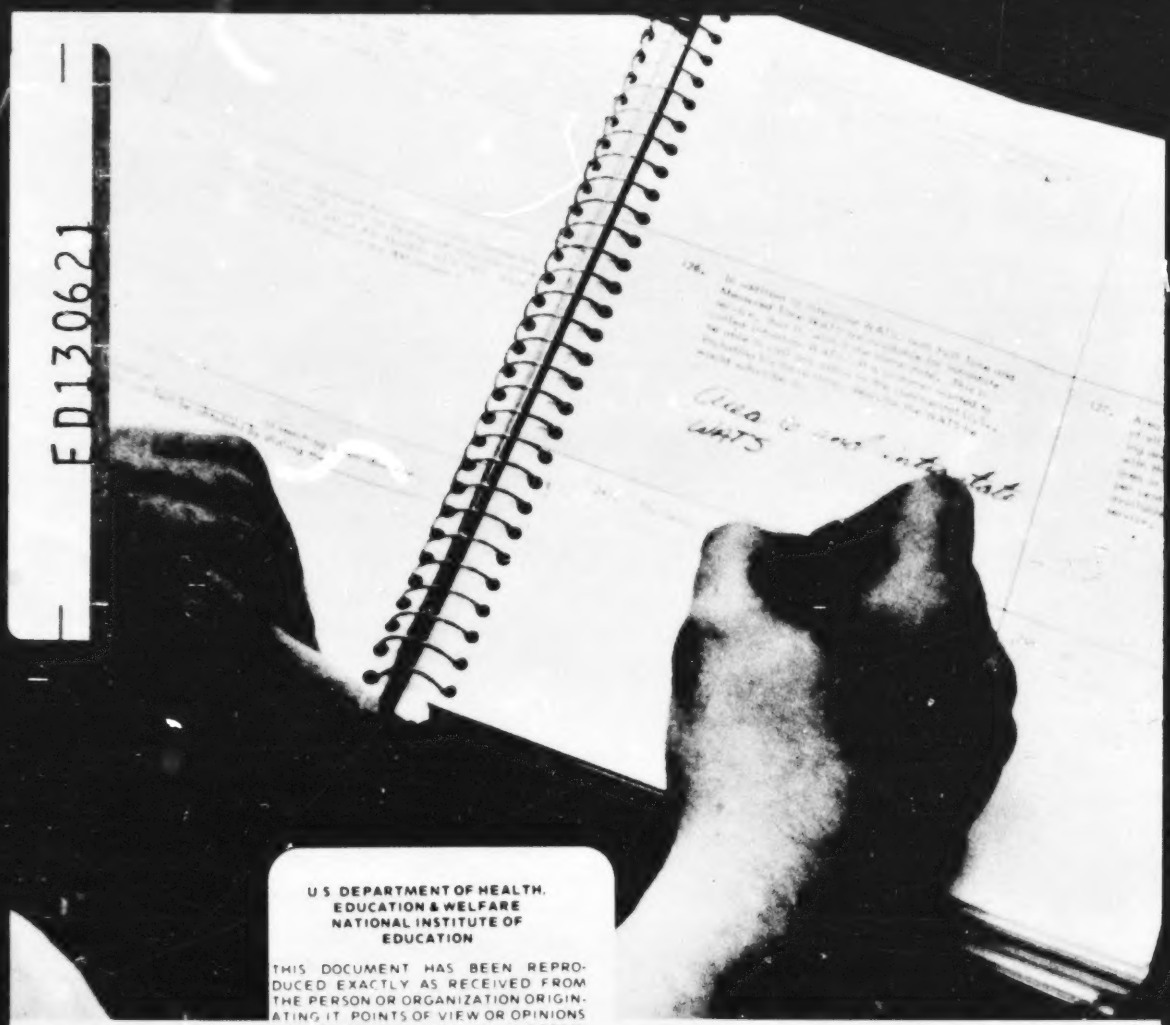

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PROGRAMED SELF-INSTRUCTION

After extensive research and development work at Bell Laboratories, the Bell System is finding valuable practical applications for this exciting new teaching technique

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■ "TEACHING MACHINE," "programed textbook," "programed learning"—names which have caught the public fancy (or opposition) in recent years—all describe a new and exciting teaching method. To people concerned with industrial training it is becoming especially important. "Teaching machine" was the term used by Prof. B. F. Skinner when he first introduced the notion in 1954.[1] Later, the term "programed text," which

emphasized the importance of the instructional program *per se*, was used. Today the method is variously termed "programed instruction," "programed learning," "automated teaching," etc. I prefer the term "programed self-instruction"; it is more descriptive of the instructive materials and of the way in which they are used.

But whatever term we use, it is a subject of great interest and considerable study in the Bell System. In the System A. T. & T. is taking leadership in the development of practical uses for programed self-instruction, following research in instructional processes at Bell Laboratories. A. T. & T. has recently established the post of Director of Training Research as one important step toward keeping abreast of developments in such instructional techniques.

This interest stems in large measure from the System's growing need for highly proficient people to keep pace with modern technology. On a System-wide basis, the training job is not only massive in terms of the number of people involved but expensive. For example, in the Operating Companies, some $75 million is spent annually on the loaded salaries of non-management employees undergoing *formal* (*i.e.* classroom) training. The *total* cost, including *informal*, on-the-job training, materials and course preparation, classroom space, utilities, equipment and supplies, etc., runs a great deal higher. No wonder then that it is important for us to assess carefully something as promising in terms of greater training efficiency as programed self-instruction.

By now a good bit of evidence is in, and we are able to list several advantages and limitations of the method. But first, here is a brief summary of its characteristics. For those who wish to pursue the matter in more detail, a number of articles describing programs of self-instruction are available.[2]

Four characteristics are typical:

- *Small steps*—The subject matter is broken down into a large number of small steps organized into an instructional sequence. The student masters these steps one at a time.
- *Continual responding*—As he works through the program the learner responds to each step and in most cases either fills in blanks with missing words or makes a choice among given alternatives.

Individuals can often work on programs in their own offices without total disruption of their jobs. Here a communications consultant works on WATS program.

• *Immediate knowledge of results* — Programed books and teaching machines are designed so that the learner can turn a page, move a slide or turn a knob and know immediately whether the response he has just made is correct.

• *Self-pacing* — Each learner works with his own book or machine and works through the program at his own pace. As a result of this, the teaching environment is quite different from the usual classroom situation.

Most programs are now appearing in programed text or book form. But several are employing audio tape recordings, visual projection and combinations of various media, too. It is unrealistic, therefore, to look upon present materials as representing final developments in the field.

Some Advantages

There are several important interacting advantages of programed instruction.

First of all, there are a number of benefits which can result from the self-pacing characteristic and from the fact that learning from self-instruction programs occurs individually rather than by groups. To consider self-pacing first: several factors probably combine to determine each individual's pace. Since most programs are verbal, reading speed is certainly an important factor. Also, the extent to which the learner has prior knowledge of the subject being taught contributes to his speed. Although some studies of programed instruction have reported a correlation between the learners' IQ and the total amount of time spent on the program, these correlations are far from perfect, indicating that other factors are operating. Whatever the causes, individual speeds become apparent in the first few minutes after a group has started a program together. Bell System trainees working on programs have exhibited an interesting consistency in extremes of speed. The slowest learner takes about twice as long as the fastest. This ratio is found in many other similar industrial programs.

■ How does this speed variation offer advantages over the traditional method of group-paced teaching?

One advantage is the flexibility this allows both the learner and the course administrator. Individuals often can work through programs in their own offices, thus accomplishing two things: they save travel and living expenses which would be necessary if they went away to school; they can work on the program part-time without total disruption of their jobs. In the Bell System these advantages have been demonstrated by hundreds of salesmen who have learned about a new service and a new product by working through self-instruction programs in their own offices.

In addition, some Plant Department schools have found it advantageous to suspend rigid scheduling of their basic electricity courses since the use of programed textbooks has been introduced. Each trainee now stays in school only as long as it takes him to demonstrate his proficiency in the subject matter. He then goes back to his job immediately without waiting for the rest of the group. In addition, since students do not learn together there is no need for them to begin together. Therefore a school may, for example, offer basic electricity from October 1 to May 1 rather than list a series of class starting dates, say, two weeks apart. Such an arrangement allows managers more flexibility in assigning men to a school.

Self-pacing and individual learning also constitute major reasons given by trainees for preferring programed self-instruction to more conventional methods. It offers advantages to both slow and fast learners. Slow learners, who may drop farther and farther behind in the conventional class, have the extra time they need to grasp the elements of the subject. Faster students, often bored or even frustrated by the slow pace of typical group instruction, retain their interest by progressing quickly through the material in the course. With

Some Plant Department schools have found programed self-instruction makes it unnecessary to have rigidly scheduled classes in basic electricity. Here a group of Plant foremen work on the program before it is given to trainees.

the self-instruction method, such people are free to "burn up the course," finishing well ahead of slower fellow students. In brief, self-instruction programs help solve an age-old problem of instruction: allowing for individual differences.

Uniform Quality

There are several advantages of programed self-instruction which fall under the category of "quality control." First, let us consider what happens under conventional lecture-discussion conditions. Any time that a particular course is taught by more than one instructor it is almost certain that there will be significant differences in content. It is difficult, too, for an instructor to maintain consistency in a course as he teaches successive classes. In fact, it usually is erroneous to assume that a lecture-type course as a stable entity exists. What *does* exist is an instructor's outline. It is the instructor himself who is responsible for translating the outline into detailed teaching sequences and these sequences necessarily are highly individualized interpretations. Thus, there can be no assurance that one is getting a high quality product across several lecture-discussion classes.

The situation is quite different with a properly developed self-instruction program. In the first place, the standard procedure for producing a high quality product is to "cut and try" a program throughout its development. Specifically, this means that it is subjected to empirical trials on sample groups of the trainees for which it is intended. It is tested and revised as many times as necessary to make it meet training objectives. The final product, then, not only has been demonstrated

electron

1-58

Because electrons are so light, they move easily. The heavy protons tend to remain motionless. Ions are formed by the loss or gain of electrons.

1-59

1-59

Ions are formed when a balanced atom gains or loses _____.

1 60

electrons

1-60

The balanced carbon atom has 6 protons and 6 electrons. A positive carbon ion has ( ) protons, a negative carbon ion has ( ) protons.

1-61

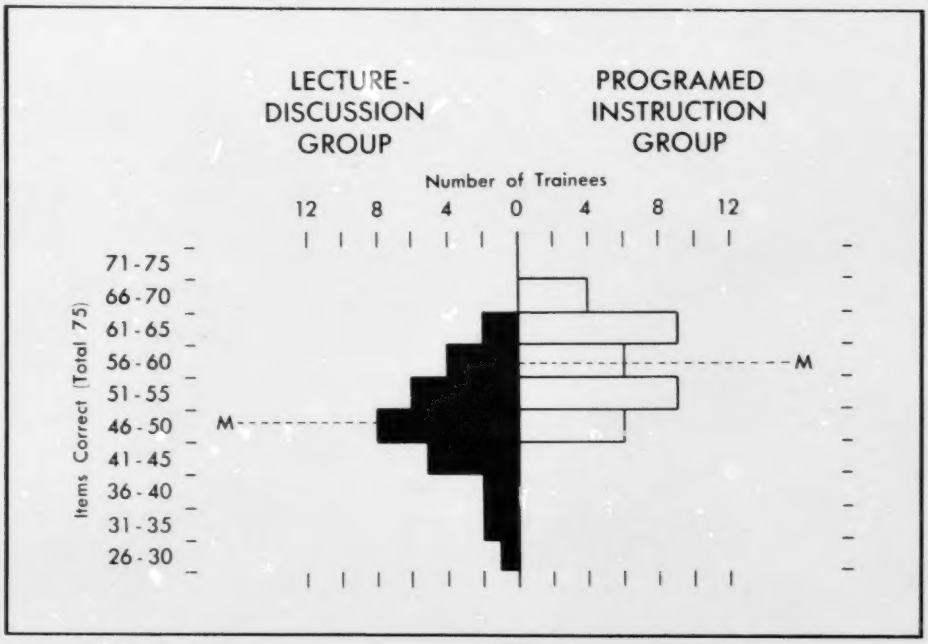
Sample frames from the A. T. & T. Basic Electricity course are shown here. To work through the sample begin at upper left. You are not asked to give a response to the first frame, so read

6, 6 1-61	The balanced aluminum atom has 13 protons and 13 electrons. A positive aluminum ion has ( ) protons, and a negative aluminum ion has ( ) protons. 1-62

13, 13 1-62	When a balanced atom accepts extra electrons, a _____ ion is formed. 1-63

negative 1-63	The name for an unbalanced atom is a (an) _____. 1-64

the second frame immediately beneath it. After you have made your response, look for the correct response to the left of the next frame, below. Proceed in the same manner throughout.



to be effective, but remains constant. That is, all students who take a particular programed course take the *same* course. Thus the instructional product can be expected to be much more uniform than the lecture-discussion product even though different groups of trainees work through the program in widely separated locations.

Evidence of one type of quality is offered by several research studies. These studies report a higher homogeneity of final examination scores than is the case with conventional instruction. That is, scores are clustered toward the high end of the scale and there are few if any failing students. (See chart, top of this page.)

■ Popular articles about programed study often promise spectacular savings in time. Certainly there are many occasions when a great deal of time is saved, but these do not by any means always occur. A programed course may, in fact, take as much time or more than its conventional counterpart. For example, in an experimental study conducted by the Bell Laboratories, a self-instruction course was written so that its content matched that of a concurrent lecture-demonstration course in basic electricity. Several classes in each method were compared. Although average proficiency of the self-instruction group was significantly higher than that of the lecture-discussion group, the average time taken by the two groups was practically the same.[1] Since the purpose of industrial training is to meet objectives directly relating to job requirements, the emphasis must be on assuring that the objectives are complete, specific and accurate, and that the training meets those objectives efficiently—rather than on time savings.

Some Limitations

While programed instruction has substantial advantages, as I have pointed out, it also has several limitations for industry which must be considered:

- An appropriate program is hard to find. There are many programs on the market, but they are primarily academically, not industrially, oriented.
- A good program — one that does an

efficient teaching job — is difficult to identify. At present it is necessary to rely on try-outs under controlled conditions to assess the quality of programs — a costly and time-consuming process.

- Program writing is also time-consuming and often requires the efforts of several people to produce an extensive program. While opinions vary as to exactly what kind of team is required to produce a good program, our opinion is that it takes four kinds of knowledge and skill: program development methods, knowledge of the subject matter, frame writing, and technical and copy editing.
- Good programs are expensive. There are various ways of estimating the cost of preparing self-instruction programs, and costs vary widely. Programs prepared under contract generally have cost from $1,000 to $1,500 per instructional hour—or from $40,000 to $60,000 for a one-week (40-hour) program.
- A good program which teaches efficiently may be irrelevant to the job being taught. This hazard is not peculiar to programed instruction, but it is sufficiently important to deserve emphasis whenever training is considered. Programed teaching is a *way* of teaching. If our objectives are erroneous, we may do a beautiful job of teaching—the wrong thing.

There are several other conditions which might limit the use of this method. For example: when the subject matter is so unstable that continual expensive revisions would be necessary; when there are so few students that the expense of a program may not be justified; when the self-pacing characteristic cannot be exploited and may, in fact, be detrimental.

■ In spite of these limitations, the evidence to date indicates that the Bell System cannot afford to overlook the potential advantages to be gained from the judicious use of programed instruction.

Four programs already have been introduced for the use of the Operating Companies. One is the previously mentioned program in basic electricity recently published by A. T. & T. Another is a complete package for the initial training of operators which integrates self-instruction with other teaching methods. The other programs were prepared under the supervision of the Marketing Department and are designed for the training of salesmen. Their subject matter is WATS and 20-40 DIAL PAK. Programing activities are also underway in other areas including some aspects of service representative training in the Commercial Department.

There is no question that the System has done a good training job in the past and it is important for us to maintain and improve that record in a context of advancing technology and increasing training needs. In a business like ours on the forefront of the new technology, it is essential that our people be given the opportunity to achieve the highest possible levels of proficiency at the lowest cost consistent with good results.

NOTES

[1] Skinner's first public pronouncement of his concept of teaching machines and their use is contained in Skinner, B. F., "The Science of Learning and the Art of Teaching," **Harvard Educational Review,** 24: 86-97, Spring 1954 pp. 99-113.

[2] Some of the more widely available articles are: Boehm, George A. W. "Can People Be Taught Like Pigeons?" **Fortune,** October 1960, p. 176; "How Machines Do Teaching Job," **Business Week,** September 17, 1960, p. 111; Luce, Gay Gaer, "Can Machines Replace Teachers?" **Saturday Evening Post,** September 24, 1960, p. 36; "Programed Learning," **Time,** March 24, 1961, p. 36; Leonard, George B., "Revolution in Education," **Look,** June 5, 1962, p. 58; Buddy, Mason, "A Businessman's Guide to Teaching Machines," **Business Management,** August 1962; Hughes, J. L., and McNamara, W. J., "The Potential of Programed Instruction," **Personnel,** Vol. 38, No. 6, November-December, 1961, pp. 59-67.

[3] Holt, H. O., and Valentine, C. G., "An Exploratory Study of the Use of a Self-Instruction Program in Basic Electricity Instruction," available from H. O. Holt, American Telephone and Telegraph Company, 195 Broadway, New York.

■ In "Some Pros and Cons of Programed Self-Instruction" (page 24) H. Oliver Holt speaks from extensive personal experience with this new and promising training technique. He joined the Bell System as personnel research supervisor for A. T. & T. in 1956. In March, 1958, he went to Bell Laboratories as director of communications social science research. While at the Laboratories Mr. Holt supervised an exploratory research study in programed instruction which he refers to in his article and which resulted in the Basic Electricity program now being used in the Bell System.

H. Oliver Holt

In December, 1962, he was appointed director of training research at A. T. & T. in which position he is coordinating the preparation of self-instructional programs and the analysis of related training problems. In addition he is helping to keep the Bell System abreast of outside developments in training technology.

Mr. Holt received the Bachelor of Arts degree in 1936 from the University of Oklahoma. In 1938 he received the Bachelor of Fine Arts degree and in 1940, the degree of Master of Education. In 1951 he received the Doctor of Philosophy degree from the University of Texas. He had wide experience in the field of training research before joining the Bell System in 1956.